SHORT-TERM CHANGES (2001–2005) IN GLOW-WORM *LAMPYRIS NOCTILUCA* L. (COLEOPTERA: LAMPYRIDAE) ABUNDANCE IN ESSEX

TIM GARDINER

Centre for Environment & Rural Affairs (CERA), Writtle College, Lordship Road, Writtle, Chelmsford, Essex, CM1 3RR, tg@writtle.ac.uk

ABSTRACT

There is much anecdotal evidence to suggest that the UK Glow-worm *Lampyris noctiluca* population has declined in the last 50 years, but there has been little scientific research to confirm this. The Essex Glow-worm Survey commenced in 2001 with the aim of documenting changes in the abundance of glowing females using a standardised transect counting procedure. Results from the first five years of monitoring on 12 transects suggest that *L. noctiluca* is declining at six sites and increasing at only three. Indeed, glow-worms appear to have disappeared from one site where no females have been seen since 2001. Worryingly, the number of females seems to have declined significantly at two sites which had high abundance in 2001. One possible reason for these reductions may be low spring rainfall which may lead to desiccation of larvae and scarcity of larval food (snails and slugs) in the pre-pupation phase in dry and hot years such as 2003. It is hoped to continue the survey in future years to determine whether glow-worms are declining in the long-term.

INTRODUCTION

The Glow-worm *Lampyris noctiluca* L. (Coleoptera: Lampyridae) has a widespread but distinctly local distribution in Britain (Tyler, 2002), apparently being more abundant in southern England, especially on areas of chalk downland (Tyler, 1994). This species is predominantly a grassland insect, although it occurs in other habitats such as hedgerows and open woodlands (British Naturalist's Association, 1971). The status of *L. noctiluca* in Britain is poorly documented; however, some efforts have been made to ascertain its national distribution. The earliest of these was a survey conducted by the British Naturalists' Association (BNA) in the 1960s and early 1970s. It was from this initial survey that a decline in the British *L. noctiluca* population was first suspected; with many recorders noting an apparent fall in numbers (BNA 1971; 1974). In 1991/92, a survey was launched by Robin Scagell (Scagell, 2003), with the aim of both revisiting the sites identified by the BNA survey and investigating previously unrecorded ones.

However, much of the evidence for a decline in the British *L. noctiluca* population collected by the British Naturalists' Association and the UK Glow-worm survey is anecdotal (Scagell, 2003) and long-term studies on the abundance of glow-worms on individual sites are rare. In an attempt to scientifically document any decline in the abundance of this species in Essex, the Essex Glow-worm Survey was initiated in 2001 (Gardiner *et al.*, 2002). As part of this survey, members of the public were asked to establish a transect at a known colony and to monitor the abundance of glowing females, using a standardised method, for a number of years. The results of this study have already been used to determine the extent of colony isolation (Gardiner *et al.*, 2003a), the influence of soil pH on abundance (Gardiner *et al.*, 2003b), differences in density of glowing females between sites (Gardiner & Pye, 2004) and the effect of grazing and mowing on colony size (Gardiner & Gardiner, 2005). It is the aim of this

paper to present the results of these standardised counts after five years of monitoring and to assess any changes in abundance over this period.

Method

A transect was established at each of 12 sites with a known *L. noctiluca* colony to allow the abundance of glowing adult females to be ascertained, thus providing comparative data on population size at different sites. Habitats recorded at the transect sites included ancient woodland and unimproved meadow (Table 1). Several of these sites had legal conservation designations, with three transects on land designated as Sites of Special Scientific Interest (SSSI). The remaining transects were established on unprotected land in the general countryside, including rural roadside verges and scrubland.

Each transect was at least 100 m in length and was walked once in each of three two-week periods: 9–22 July, 23 July–5 August, and 6–19 August on an annual basis from 2001–2005. Any glowing adult females which were observed (e.g. that could be seen from the transect) along the route were recorded. It was felt that these three periods adequately incorporated the peak glowing season in Essex when most adult females would be displaying. The main disadvantage to using transect counts of glowing females as an estimation of colony size is that females only mate once, after which they stop glowing (Tyler, 2002). Therefore, low numbers of glowing females at a site may indicate successful breeding on previous nights rather than a small colony. Seven transects were walked in all five years, whereas, at five sites it was not possible to survey every year due to practical difficulties or the unavailability of suitable volunteers to walk the route.

Survey participants were required to commence each walk between 2200 and 2300 h, and to terminate by 0000 h. However, most walks were started at approximately 2200 h and had finished by 2300 h. Therefore, very few walks finished after 2330 h when females may have 'switched off' for the night. A slow strolling pace (0.7 km/h was the average searching/walking speed) was recommended for the walks

Table 1. Characteristics of the transect sites in Essex

Site name	Grid ref.	No. females counted	Description
Bulford Mill Lane	TL7720	64	Roadside verge with mature hedgerow
Danbury Woods	TL7806	70	Ancient woodland with rides and glades
Dry Street	TQ6986	26	Hedgerow with grassy path
Finches Nature Area	TQ9094	169	Scrub with rides and glades
Hadleigh Castle	TQ8186	89	Rough grassland and scrub around castle walls
Hatfield Forest	TL5420	20	Ancient grazed grassland adjoining ancient woodland
Iron Latch	TL9526	100	Restored meadow with fringing scrub and ancient woodland
Manwood Chase	TM0019	111	Meadow, scrub and woodland
Marks Hill	TQ6888	5	Hedgerow with grassy path
One Tree Hill	TQ7086	644	A mixture of meadow, scrub and woodland
Saffron Walden	TL5538	54	Area of amenity grassland in hospital grounds
Shut Heath Wood	TL8513	26	Ancient woodland with glades

to reduce the risk of overlooking glowing females along the route. Participants were asked not to conduct surveys in unfavourable conditions, for example, when it was cold, wet or windy, because counts may be reduced under such climatic extremes (Alexander, 1992). Inevitably some counts were undertaken when it was wet or cold.

Statistical analysis

The density of glowing females per 100 m was calculated for every walk conducted to allow a comparative measure of *L. noctiluca* abundance between sites with differing transect lengths. Counts of insects in grasslands can be very variable and many zero counts are often recorded and this influences the strategies appropriate for the analysis of data (Gardiner *et al.*, 2005b). In swards of variable structure it is safer to use distribution-free non-parametric statistics (Wilcoxon's paired samples test or similar) to avoid any misinterpretation of inferences drawn after analysis (Gardiner *et al.*, 2005b). Therefore due to the extremely heterogeneous vegetation structure of the sites (some were grazed and had extremely variable sward height), it was decided to use non-parametric statistics to analyse the data. The median density of females per 100 m/survey for 2001 and 2005 was compared at every site using Wilcoxon's paired samples test to determine any significant changes in abundance over the monitoring period. As there were only three surveys to compare in both years (e.g. only three replicates per site for each year), statistical significance was accepted at $P = 0.10$. This approach has been used in other studies of insects such as Orthoptera where there was low replication (e.g. in Culm grasslands: Gardiner *et al.*, 2005a).

A relationship was suspected between spring rainfall and the abundance of females. To test this theory and ascertain whether rainfall influenced glow-worm density, Spearman's rank correlation was used to determine significant relationships between spring rainfall (total rainfall for March-May) and female abundance in each year for sites where female abundance was significantly different in 2001 and 2005 (e.g. where significant declines or increases were evident). Rainfall data were obtained from the Writtle College Weather Station (grid ref: TL678066) (Writtle College, 2004).

Results and discussion

The number of counts undertaken each year declined over the five years of the survey, although there were always >26 counts each year (Table 2). The highest count of females during the survey was 101 at One Tree Hill in 2002. Generally, most counts were very low (<10 individuals per survey). The highest overall densities (median of all counts at all sites) were in 2002 and 2005, with very low abundance of females (<1 female per 100 m) recorded at many sites in the very dry and hot 2003 (Table 2). However, comparisons between the overall abundance of *L. noctiluca* in different years, hides wide variations in female density between different years at individuals sites. *Lampyris noctiluca* appears to be declining at six sites and increasing at only three (Table 3). At Marks Hill, this species seems to have disappeared over the course of the monitoring period and was last seen in 2001. The number of females seen per night in the mid 1980s at this site was in excess of 50 (Mandy Greig, pers.comm.) so there may have been a long-term decline. The habitat at Marks Hill has remained superficially similar (e.g. hedgerow and mown verge habitat) for many years, therefore reasons for the decline and possible extinction remain unclear. Future monitoring should ascertain whether *L. noctiluca* has indeed become extinct at this site.

Table 2. Characteristics of the Essex *Lampyris noctiluca* survey

Characteristic	Year 2001	2002	2003	2004	2005
Median no. of females per 100 m/survey	1.78	1.83	0.95	1.00	2.00
Total no. of females	439	327	209	191	212
Maximum count	76	101	78	39	30
Total no. of counts	36	36	27	27	33
Climate					
Spring rainfall (March–May) mm	196.1	143.9	82.9	140.8	89.0

Worryingly, two of the colonies (One Tree Hill and Manwood Chase) with high female density in 2001 (>5 females per 100 m) have experienced significant reductions in abundance (Wilcoxon's value for both sites: -1.60, $P \leqslant 0.10$) over the monitoring period (Table 3).

Low spring rainfall (March–May; Table 2) may have led to reduced abundance of females at both sites in later years of the survey (particularly 2003 and 2005; Table 3). Indeed, there was a significant positive correlation between spring rainfall and the density of females in each year on both transects (r_s value for One Tree Hill: 0.82, $P<0.05$; r_s for Manwood Chase: 0.90, $P<0.05$). These results suggest that mature larvae in the pre-pupation phase in the spring months may have been unable to find sufficient snail prey to metamorphose into adults (which do not feed) later in the summer. Therefore, drought conditions in spring may lead to a scarcity of larval food (snails being more active in wet weather) and even desiccation of larvae in the pre-pupation phase in very dry and hot years such as 2003. There will of course be cumulative effects from drought conditions, for example, low numbers of females in 2003 will lead to fewer occurrences of mating and a low number of eggs being laid. This species has a two-year life cycle (e.g. larvae hatching in 2001 will become adult in 2003) and the low abundance of *L. noctiluca* in 2003 may have led to the low female density in 2005 (Table 3).

Soil conditions at the large colonies may have compounded the scarcity of snails in dry years. The soil at Manwood Chase is well drained (82% sand, unpublished data), whereas, at One Tree Hill, the transect was located on a south facing ridge where the well drained silt soil (74% silt, unpublished data) may increase larval scarcity in dry weather. Indeed, anecdotal evidence from One Tree Hill suggests that females have become increasingly restricted to damp hollows as the survey has progressed and may have a preference for the wetter north facing side of the ridge (Nick Stanley, pers.comm.). The importance of soil type seems to be confirmed by the lack of significant female declines at sites located on clay soils (e.g. Finches Nature Area, Iron Latch and Shut Heath Wood; Table 3) where water retention may be higher in dry years. However, data collected over a longer-time period is needed to determine the influence of soil type on glow-worm declines.

At Bulford Mill Lane there was a significant increase in female density over the five years (Wilcoxon's value: -1.60, $P \leqslant 0.10$). This site is a grassy roadside and the increase may reflect larvae spreading to uncolonised parts of the verge (Lin Wenlock, pers.comm.). The colony also connects with an active railway line which is known to support large glow-worm populations, which may be another source of migrating individuals. Such interconnected linear habitats may have a very important role to play in the future conservation of *L. noctiluca* in fragmented habitats (Gardiner & Tyler, 2002).

Table 3. Median number of females per 100m/survey at different transect sites with continuous (all years surveyed) and discontinuous (some years not surveyed) monitoring

Site	Year						
	2001	2002	2003	2004	2005	Status*	Sig**
Continuous monitoring							
One Tree Hill	5.6	4.0	3.6	3.6	1.5	–	$P \leqslant 0.10$
Manwood Chase	5.3	3.0	0.3	2.3	0.0	–	$P \leqslant 0.10$
Finches Nature Area	2.5	1.7	1.3	2.7	2.3	=	NS
Shut Heath Wood	1.0	2.0	1.0	0.0	2.0	=	NS
Danbury Woods	0.6	0.1	0.0	0.1	0.1	–	NS
Iron Latch	0.4	2.4	3.6	2.0	2.8	+	NS
Hatfield Forest	< 0.1	< 0.1	0.0	< 0.1	< 0.1	=	NS
Discontinuous monitoring							
Hadleigh Castle	5.9	5.5	NC	NC	3.0	–	NS
Saffron Walden	2.9	3.3	1.0	NC	0.5	–	NS
Marks Hill	2.0	0.0	NC	0.0	0.0	×	NS
Dry Street	1.0	2.0	NC	3.0	4.0	+	NS
Bulford Mill Lane	1.0	0.3	2.7	NC	3.7	+	$P \leqslant 0.10$

NC = no counts in that year
*status codes: – declining, + increasing, = no change, × = declining possibly extinct
**statistical significance between median values for 2001 and 2005 at $P \leqslant 0.10$ is shown, no significance is indicated as NS.

Caution must be exerted as the survey has only run for five years and more long-term data are needed to confirm declines and increases in glow-worm abundance and the potentially important relationship between spring rainfall and female abundance. It is hoped to continue the survey indefinitely to try to provide this information.

To provide more valid data in future survey years, refinements are needed to the sampling method. It has become clear that the highest female counts are in the first walk period (9–22 July) with lower numbers seen in periods 2 (23 July–5 August) and 3 (6–19 August). This indicates that the survey is starting too late in the female season, which is confirmed by reports from recorders of high numbers in late June/early July in 2005 (Mike Wright, pers.comm.). Therefore, an earlier survey period (25 June–8 July) will be tested in future years.

Other refinements to the survey criteria are necessary due to variation in female counts as a result of walk timing and weather conditions:

(i) Avoid surveying on cloudless nights (< 33% cloud cover) with a full moon due to difficulty in detecting females (Gardiner, 2006a).

(ii) Only undertake counts in dry weather as female numbers appear to be much higher on nights with heavy rain or drizzle (Gardiner, 2006c).

(iii) Start surveys between 2200–2230 h in periods 2 and 3 (23 July–19 August) as counts are very low after 2230 h in late summer (Gardiner, 2006b).

Acknowledgements

The author would like to thank all survey participants who walked transects at the different sites and to Essex Wildlife Trust for allowing surveys on their nature reserves. My gratitude is also extended to Writtle College for providing finance and resources for the duration of the survey.

References

Alexander, K.N.A. 1992. The Glow-worm, *Lampyris noctiluca* (L.), in Gloucestershire and its conservation. *The Gloucestershire Naturalist* **5**: 1–5.

British Naturalists' Association 1971. Glow-worm survey. *Country-side* **21**: 456–463, 572–574.

British Naturalists' Association 1974. Glow-worm survey. *Country-side* **22**: 266–271.

Gardiner, T. 2006a. Does the phase of the moon affect Glow-worm *Lampyris noctiluca* L. (Lampyridae) counts? *The Coleopterist* **15**: 92.

Gardiner, T. 2006b. Effect of survey start time on counts of the Glow-worm *Lampyris noctiluca* (Col.: Lampyridae). *Entomologist's Record & Journal of Variation* **118**: 184–185.

Gardiner, T. 2006c. Glowin' in the rain. *Bulletin of the Amateur Entomologists' Society* **65**: 146–147.

Gardiner, T. & Gardiner, M. 2005. Monitoring Glow-worm *Lampyris noctiluca* L. (Col.: Lampyridae) populations in grazed and mown grasslands. *Entomologists' Record & Journal of Variation* **117**: 263–266.

Gardiner, T., Gardiner, M. & Hill, J. 2005a. The effect of pasture improvement and burning on Orthoptera populations of Culm grasslands in northwest Devon, UK. *Journal of Orthoptera Research* **14**: 153–159.

Gardiner, T., Hill, J. & Chesmore, D. 2005b. Review of the methods frequently used to estimate the abundance of Orthoptera in grassland ecosystems. *Journal of Insect Conservation* **9**: 151–173.

Gardiner, T. & Pye, M. 2004. Transect monitoring of Glow-worm *Lampyris noctiluca* (Coleoptera: Lampyridae) colonies in Essex. *Essex Naturalist* **21:** 167–168.

Gardiner, T., Pye, M. & Field, R. 2002. Glow-worms *Lampyris noctiluca* L. (Coleoptera: Lampyridae) in Essex: results of the 2001 Essex Glow-worm Survey. *Essex Naturalist* **19**: 151–159.

Gardiner, T., Pye, M. & Field, R. 2003a. The Glow-worm *Lampyris noctiluca* L. (Coleoptera: Lampyridae) in Essex. *British Journal of Entomology and Natural History* **16**: 233–240.

Gardiner, T., Pye, M. & Field, R. 2003b. The influence of soil pH on the abundance of the Glow-worm *Lampyris noctiluca* (Linnaeus) (Lampyridae) in Essex. *The Coleopterist* **12**: 121–123.

Gardiner, T. & Tyler, J. 2002. Are glow-worms disappearing? *British Wildlife* **13**: 313–319.

Scagell, R. 2003. *1992. Glow worm report* [www document]. <http://website.lineone.net/~galaxypix/92report.html> (accessed 10 April 2003).

Tyler, J. 2002. *The Glow-worm*. Lakeside Press, Sevenoaks.

Tyler, J. 1994. *Glow-worms*. Tyler-Scagell, Sevenoaks.

Writtle College 2004. *Writtle College Annual Weather Report 2003*. Writtle College, Chelmsford.

SHORT COMMUNICATION

More records of *Iassus scutellaris* (Fieber) (Hemiptera: Cicadellidae) in southern England. – Alex Ramsay's recent note (Ramsay, 2006) prompted me to unearth some recent records of this attractive hopper, including Berkshire records which predate his from Reading. I first took it in Berkshire at Cow Common (SU4392) (modern Oxfordshire), on 23.vii.1998. It was also locally abundant on elm hedges in the lower Kennet valley close to Reading around Sheffield Bottom and Theale Lake (SU6469), and Burghfield Mill (SU6770) in vii–ix.2004. In Surrey it seems to be present on most of the good stands of elm that I have sampled (e.g. Hatchlands (TQ0651) 25.vii.2001, West End Esher Common (TQ1262) vi.2004, Effingham (TQ1057) 3.ix.2006). It would appear to be a quite mobile species as it occurs on quite isolated stands of elm, as on Canvey Island, South Essex (TQ7782), vii–ix.2006. In my experience the bulk of adults are all bright green, but specimens with a dark thorax are not uncommon and look very like the commoner *Iassus lanio*, which is a problem in hedgerows with oak and elm mixed together. – Dr. Jonty Denton, 29 Yarnhams Close, Four Marks, Hants, GU34 5DH.

Reference

Ramsay, A.J. 2006. *Iassus scutellaris* (Fieber) (Hemiptera: Auchenorrhyncha) new to Berkshire. *British Journal of Entomology & Natural History* **19**: 238.